

# Non-cognitive Development and Peer Effect: Experimental Evidence from Chinese Rural Boarding Schools

Yue Li, Peiyi Jin

Supervisors: Orazio Attanasio, Áureo de Paula, Michela M. Tincani

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# Introduction

# Motivation



(a) Rebellion to Adults



(b) Friends

- Motivation 1: providing a substitute for parental companionship
  - A lack of parental companionship might cause emotional and behavioural disorders (Hoeve et al., 2012)
  - Why should we care about Rural boarding schools: [overview](#)
- Motivation 2: identifying the peer spillover effect
- Research question: How do peer non-cognitive skills influence an individual's own non-cognitive skills?

# This Paper

- The program plays audio-bedtime stories in school dormitories: cleanly separates students into treated and untreated groups within the treatment and control groups
- Treatment effect on board students and spillover effects on day students
- Heterogeneous treatment and spillover effects in relation to social networks
- How average peer non-cognitive skills affect one's non-cognitive skills (treatment and peer's distance from home as IV)

# Literature

- Basis: Non-cognitive skills exhibit susceptibility to modification through interventions (Shnabel et al., 2013; Cohen and Sherman, 2014; Shan and Zöllitz, 2022).
  - Limited examination concerning the spillover effects influencing channels
- Peer effects: Peers' gender, race, or academic achievements, shape the academic performance of individuals and their choices in education (Hoxby, 2000; Figlio, 2007; Sacerdote, 2014).
  - Disagreement on how peer non-cognitive skills affect own non-cognitive skills (Shan and Zöllitz, 2022; Bietenbeck, 2021; Boucher et al., 2022)
  - Lack of student network data limited definition of peers to classmates (Feng et al., 2024; Cattan et al., 2023; Garlick, 2018)(Sacerdote, 2001; Carman and Zhang, 2012; Feld and Zöllitz, 2017; Zárate, 2023; Hu, 2023)
- Identification challenge: Correlated effects VS real social effects (Manski, 1993, 2013)

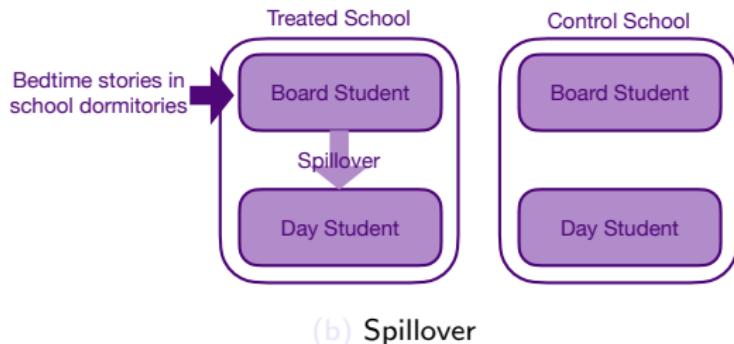
## The Intervention and Data

# The Intervention

- Intervention: The project plays 15-minute bedtime stories through speakers in school dormitories. [stories](#) [feedback](#) [share](#)
- Randomization at the school level: treatment 30; control 33 schools



(a) Listening to Stories



- Board students live in school dormitories: direct effects → treatment effect
- Day students go home at night: **no direct effects** → spillover effect

# The Intervention Timeline

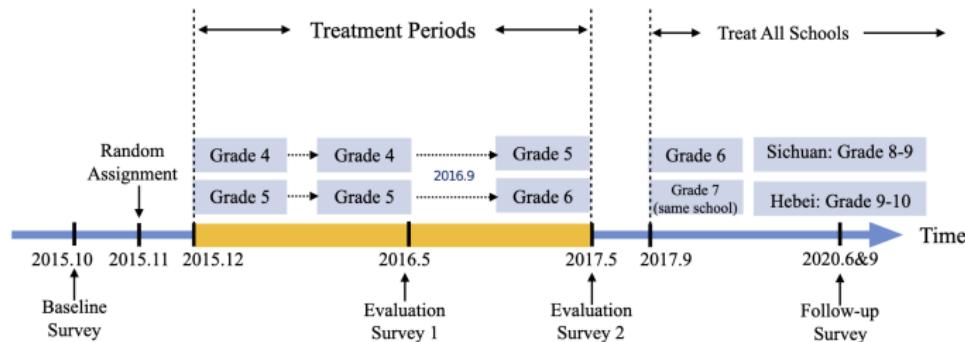


Figure: Timeline

- 6 months(4 months), 18 months(14 months)
- Scaling: 10,039 schools in 948 counties in 29 provinces, 3.99 million children.

# Data Descriptive

- Sample characteristics:

- Sample Distribution distribution
- Baseline Descriptive

|  | Variable           | Obs   | Mean    | Std.   | Min     | Max     |
|--|--------------------|-------|---------|--------|---------|---------|
| Personal characteristics               | age                | 8,236 | 10.238  | 0.833  | 7.280   | 14.409  |
|  | gender             | 8,236 | 0.506   | 0.500  | 0       | 1       |
|  | grade              | 8,236 | 4.500   | 0.500  | 4       | 5       |
|  | board              | 8,236 | 0.589   | 0.492  | 0       | 1       |
|  | left-behind        | 8,236 | 0.433   | 0.496  | 0       | 1       |
|  | height             | 8,235 | 138.805 | 7.749  | 112.500 | 174.000 |
| Family Characteristics                 | weight             | 8,235 | 33.160  | 7.942  | 17.500  | 84.200  |
|  | father's education | 8,235 | 8.805   | 2.098  | 6       | 19      |
|  | mother's education | 8,234 | 8.314   | 2.094  | 6       | 19      |
|  | #siblings          | 8,236 | 2.178   | 0.913  | 1       | 8       |
|  | Parents' Marriage  | 8,236 | 0.119   | 0.324  | 0       | 1       |
| Non-cognitive skills and mental health | Resilience         | 8,112 | 128.402 | 15.002 | 76.824  | 171.000 |
|  | Self-esteem        | 8,178 | 15.712  | 4.023  | 0       | 30      |
|  | Internalization    | 8,143 | 35.512  | 7.492  | 18      | 70      |
|  | Externalization    | 8,140 | 28.568  | 7.721  | 18      | 71      |
|  | Depression         | 8,105 | 19.002  | 8.918  | 0       | 60      |

- Balance test balance test

- Attrition attrition

## Motivating Results

# Empirical Strategy

- Estimating equation:

$$Y_{is,t} = \beta_0^k + \beta_1^k T_{s,0} + \sigma^k Y_{is,0} + \gamma^k X_{is,0} + \alpha_c^k + \epsilon_{is,t}^k$$

where  $k \in \{\text{day, board}\}$

- $Y_{is,t}$  represents the factor score of certain outcome for individual  $i$  at time  $t$   
factor analysis
- $T_{s,0}$  is a treatment indicator that takes on the value 1 if i's school s is assigned to the treatment group
- $Y_{is,0}$ : same outcome measured at baseline
- $X_{is,0}$ : control variables (a set of characteristics at baseline that were imbalanced across treatment and control at t, baseline individual/family characteristics like parent education level etc.)
- $\alpha_c$ : County fixed effect, SEs clustered at the school level
- Regressions are run separately for board students and day students

# Treatment Effect

|              | Personal Resilience | Social Resilience | Internalization   | Externalization   | Self-esteem      | Depression         |
|--------------|---------------------|-------------------|-------------------|-------------------|------------------|--------------------|
| 2016         |                     |                   |                   |                   |                  |                    |
| Treatment    | 0.038<br>(0.053)    | 0.034<br>(0.053)  | -0.032<br>(0.045) | -0.015<br>(0.037) | 0.044<br>(0.050) | 0.085**<br>(0.037) |
| P-value      | 0.479               | 0.519             | 0.474             | 0.695             | 0.378            | 0.024              |
| RW p-value   | 0.847               | 0.847             | 0.847             | 0.847             | 0.847            | 0.461              |
| Control Mean | -0.002              | -0.003            | -0.158            | -0.158            | -0.014           | 0.040              |
| Observations | 5,055               | 5,055             | 4,420             | 4,488             | 5,055            | 4,997              |
| 2017         |                     |                   |                   |                   |                  |                    |
| Treatment    | 0.086*<br>(0.049)   | 0.074<br>(0.048)  | -0.016<br>(0.054) | -0.040<br>(0.052) | 0.068<br>(0.047) | 0.004<br>(0.040)   |
| P-value      | 0.084               | 0.124             | 0.765             | 0.444             | 0.153            | 0.929              |
| RW p-value   | 0.373               | 0.489             | 0.914             | 0.847             | 0.597            | 0.981              |
| Control Mean | 0.043               | 0.054             | -0.112            | -0.127            | 0.041            | 0.055              |
| Observations | 5,084               | 5,084             | 4,812             | 4,836             | 5,084            | 5,074              |

# Spillover Effect

|              | Personal Resilience | Social Resilience | Internalization   | Externalization   | Self-esteem         | Depression        |
|--------------|---------------------|-------------------|-------------------|-------------------|---------------------|-------------------|
| 2016         |                     |                   |                   |                   |                     |                   |
| Treatment    | 0.053<br>(0.056)    | 0.044<br>(0.054)  | -0.079<br>(0.063) | -0.068<br>(0.050) | 0.059<br>(0.055)    | -0.015<br>(0.051) |
| P-value      | 0.340               | 0.424             | 0.216             | 0.177             | 0.289               | 0.775             |
| RW p-value   | 0.712               | 0.773             | 0.544             | 0.557             | 0.682               | 0.912             |
| Control Mean | 0.092               | 0.094             | -0.259            | -0.248            | 0.077               | -0.123            |
| Observations | 3,120               | 3,120             | 2,729             | 2,795             | 3,120               | 3,093             |
| 2017         |                     |                   |                   |                   |                     |                   |
| Treatment    | 0.117*<br>(0.063)   | 0.097<br>(0.065)  | 0.019<br>(0.053)  | 0.046<br>(0.040)  | 0.159***<br>(0.058) | -0.089<br>(0.066) |
| P-value      | 0.068               | 0.140             | 0.727             | 0.260             | 0.008               | 0.187             |
| RW p-value   | 0.290               | 0.476             | 0.912             | 0.728             | 0.076               | 0.515             |
| Control Mean | 0.092               | 0.104             | -0.189            | -0.243            | 0.077               | -0.072            |
| Observations | 2,894               | 2,894             | 2,710             | 2,763             | 2,894               | 2,883             |

# Influencing Channel: Friend Network

- The spillover effect are driven by day students who have board friends.
- (1)(2): day students with board friends;  
 (3)(4): day students without board friends

|              | (1)<br>Personal<br>Resilience | (2)<br>Self-esteem  | (3)<br>Personal<br>Resilience | (4)<br>Self-esteem |
|--------------|-------------------------------|---------------------|-------------------------------|--------------------|
| Treatment    | 0.109*<br>(0.063)             | 0.167***<br>(0.055) | 0.085<br>(0.092)              | 0.078<br>(0.092)   |
| P value      | 0.090                         | 0.004               | 0.361                         | 0.404              |
| RW p-value   | 0.150                         | 0.041               | 0.350                         | 0.350              |
| Observations | 2,017                         | 2,017               | 877                           | 877                |

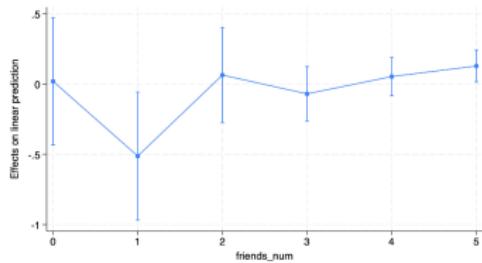
# Influencing Channel: Friend Network

- The treatment effect are larger for board students who have day friends/friends.
- (1)(2): board students with day friends;  
 (3)(4): board students without day friends  
 (5)(6): board students with friends  
 (7)(8): board students without friends

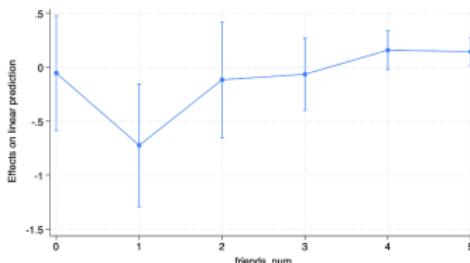
|              | (1)<br>Personal<br>Resilience | (2)<br>Self-esteem | (3)<br>Personal<br>Resilience | (4)<br>Self-esteem | (5)<br>Personal<br>Resilience | (6)<br>Self-esteem | (7)<br>Personal<br>Resilience | (8)<br>Self-esteem |
|--------------|-------------------------------|--------------------|-------------------------------|--------------------|-------------------------------|--------------------|-------------------------------|--------------------|
| Treatment    | 0.115*<br>(0.060)             | 0.092<br>(0.056)   | 0.048<br>(0.059)              | 0.034<br>(0.065)   | 0.085*<br>(0.049)             | 0.064<br>(0.048)   | -0.145<br>(0.212)             | 0.014<br>(0.191)   |
| P value      | 0.060                         | 0.104              | 0.417                         | 0.599              | 0.087                         | 0.189              | 0.498                         | 0.944              |
| RW p-value   | 0.165                         | 0.312              | 0.618                         | 0.751              | 0.120                         | 0.312              | 0.751                         | 0.942              |
| Observations | 2,389                         | 2,389              | 2,695                         | 2,695              | 4,947                         | 4,947              | 138                           | 138                |

# Number of Friends

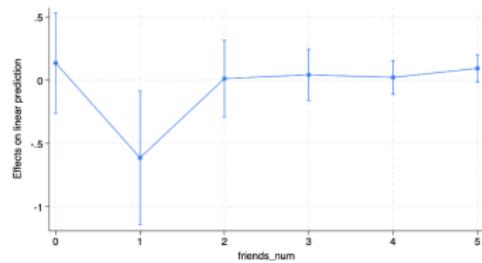
- The more friends a student has, the larger the treatment and spillover effect



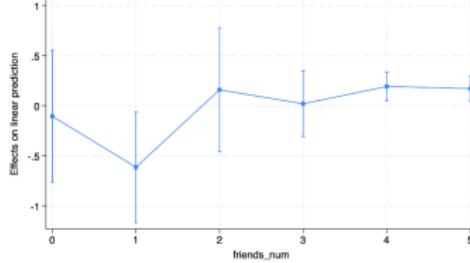
(1) Treatment Effect on Personal Resilience



(2) Spillover Effect on Personal Resilience



(3) Treatment Effect on Self-esteem



(4) Spillover Effect on Self-esteem

# No Change in Network Structure

- The treatment did not make a difference to their network structure

|              | # Board Friends   | %Female Friends   | # Persistent Friends |
|--------------|-------------------|-------------------|----------------------|
| Treatment    | -0.303<br>(0.204) | -0.002<br>(0.005) | -0.179<br>(0.241)    |
| After        | 0.153<br>(0.100)  | 0.008<br>(0.006)  | -2.586***<br>(0.159) |
| Interaction  | 0.079<br>(0.142)  | 0.001<br>(0.008)  | 0.261<br>(0.165)     |
| P-value      | 0.581             | 0.899             | 0.119                |
| RW p-value   | 0.664             | 0.891             | 0.149                |
| Observations | 6,297             | 5,962             | 6,297                |

## Channel 1: Peer Outcome Influence

# Linear-in-Means Model

- Production function:

$$y_i = x_i \gamma + \lambda \bar{y}_{-i} + \alpha_c + \epsilon_i \text{ where } \bar{y}_{-i} = \sum_j \tilde{g}_{ij} \cdot y_j$$

- Adjacency matrix  $G_{n*n} = [g_{ij}]$ :  $g_{ij} = 1$  if i nominated j as board friend otherwise 0
- $n_i$ : number of nominated board friends
- $\tilde{G}_{n*n} = [\tilde{g}_{ij}]$  where  $\tilde{g}_{ij} := g_{ij}/n_i$
- $x_i$ : gender, age, age square, distance from home, parents' education level

- Instrumental variables:

- treatment status ( $T_s$ )
- characteristics of peers' peers' ( $\tilde{X}_{-i}^{(2)}$ ) but not direct peers (Bramoullé et al. (2009))

- Exclusive restriction:  $\mathbb{E}(z_i \epsilon_i) = 0$

- Treatment: the audio bedtime story treats board students through dormitory speakers so won't directly affect day students
- The characteristics of peers of peers who are not direct peers affect an individual's outcome only through their effect on peers' outcomes

# Linear Model First Stage

- Relevance:  $\mathbb{E}(z_i \bar{y}_{-i}) \neq 0 \Rightarrow \bar{y}_{-i} = \alpha_1 x_i + \alpha_2 z_i + \mu_i$

|                                     | Friends 1-3         |                     |                    | Friends 1-5         |                   |                   | Class Average       |                     |                     |
|-------------------------------------|---------------------|---------------------|--------------------|---------------------|-------------------|-------------------|---------------------|---------------------|---------------------|
|                                     | Personal Resilience | Social Resilience   | Self-esteem        | Personal Resilience | Social Resilience | Self-esteem       | Personal Resilience | Social Resilience   | Self-esteem         |
| Treatment                           | 0.121**<br>(0.058)  | 0.143**<br>(0.063)  | 0.102<br>(0.075)   | 0.079<br>(0.073)    | 0.121<br>(0.080)  | 0.123<br>(0.085)  | 0.189***<br>(0.068) | 0.170**<br>(0.068)  | 0.163**<br>(0.063)  |
| Peers' peers' gender                | -0.364**<br>(0.178) | -0.361**<br>(0.166) | -0.199<br>(0.162)  | -0.370*<br>(0.212)  | -0.283<br>(0.210) | -0.096<br>(0.203) | -0.023<br>(0.046)   | -0.037<br>(0.049)   | -0.007<br>(0.042)   |
| Peers' peers' father educ           | 0.205*<br>(0.106)   | 0.223**<br>(0.109)  | 0.241**<br>(0.111) | 0.251<br>(0.332)    | 0.265<br>(0.338)  | 0.070<br>(0.337)  | 0.011<br>(0.081)    | 0.016<br>(0.078)    | -0.037<br>(0.099)   |
| Peers' peers' mother educ           | -0.049<br>(0.102)   | -0.151<br>(0.156)   | -0.296<br>(0.206)  | -0.095<br>(0.304)   | -0.221<br>(0.364) | -0.294<br>(0.416) | -0.174**<br>(0.076) | -0.154**<br>(0.071) | -0.184**<br>(0.084) |
| Peers' peers' parents marriage stat | 0.712***<br>(0.239) | 0.682***<br>(0.252) | 0.584**<br>(0.252) | 0.502*<br>(0.275)   | 0.492*<br>(0.299) | 0.311<br>(0.317)  | -0.086<br>(0.235)   | -0.112<br>(0.244)   | -0.062<br>(0.227)   |
| Peers' peers' left-behind status    | 0.116<br>(0.463)    | 0.055<br>(0.488)    | -0.260<br>(0.530)  | -0.052<br>(0.728)   | -0.100<br>(0.744) | -0.146<br>(0.744) | -0.291<br>(0.274)   | -0.329<br>(0.255)   | -0.260<br>(0.283)   |
| F-statistics                        | 7.16                | 8.52                | 4.97               | 5.30                | 6.78              | 4.04              | 10.939              | 11.318              | 9.790               |
| Observations                        | 1,103               | 1,103               | 1,103              | 1,088               | 1,088             | 1,088             | 2,703               | 2,703               | 2,703               |

# IV Estimation Results

|               | Friends 1-3         |                    |                     | Friends 1-5         |                   |                     | Class Average       |                    |                     |
|---------------|---------------------|--------------------|---------------------|---------------------|-------------------|---------------------|---------------------|--------------------|---------------------|
|               | Personal Resilience | Social Resilience  | Self-esteem         | Personal Resilience | Social Resilience | Self-esteem         | Personal Resilience | Social Resilience  | Self-esteem         |
| IV estimation | 0.564***<br>(0.197) | 0.455**<br>(0.222) | 0.979***<br>(0.257) | 0.682**<br>(0.273)  | 0.543*<br>(0.279) | 0.909***<br>(0.314) | 0.499***<br>(0.174) | 0.463**<br>(0.202) | 0.657***<br>(0.172) |
| F-statistics  | 7.16                | 8.52               | 4.97                | 5.30                | 6.78              | 4.04                | 10.939              | 11.318             | 9.790               |
| Observations  | 1,103               | 1,103              | 1,103               | 1,088               | 1,088             | 1,088               | 2,703               | 2,703              | 2,703               |

- Both friends 1–3, friends 4–5 and class average show significant positive impacts.

**Table: Indirect Effects via ~Friends 1–3 Exposure (Bootstrap)**

| Outcome     | Indirect Effect | SE (Bootstrap) | p-value |
|-------------|-----------------|----------------|---------|
| Resilience2 | 0.020***        | 0.0073         | 0.006   |
| Resilience1 | 0.016**         | 0.0069         | 0.019   |
| Self-esteem | 0.013*          | 0.0068         | 0.049   |

*Note:* Bootstrap SEs based on 500 replications (20 with errors). Significance levels: \* $p < 0.05$ , \*\* $p < 0.01$ , \*\*\* $p < 0.01$ .

## Channel 2: Sharing Behaviour

# Measurement

- Q: If you have listened to the bedtime stories, who did you share them with?
  - my parents
  - my roommates
  - my older siblings
  - my younger siblings
  - day students
- $share_{day} = 1$  if e is chosen and 0 otherwise
- $Pshare = \text{proportion of nominated friends being treated, boarding and shared with day students.}$
- Instrumental variables: treatment status ( $T_s$ )

# First-stage: Sharing

- Relevance:  $\mathbb{E}(z_i \bar{y}_{-i}) \neq 0 \Rightarrow \bar{y}_{-i} = \alpha_1 T_i + \alpha_2 X_i + \alpha_3 P_{-i} + \mu_i$

|                                  | Probability of being shared |
|----------------------------------|-----------------------------|
| Treatment                        | 0.131***<br>(0.018)         |
| Personal Resilience F-statistics | 74.372                      |
| Social Resilience F-statistics   | 76.000                      |
| Self-esteem F-statistics         | 69.958                      |
| Observations                     | 1,938                       |

# IV Estimation: Sharing

- Is sharing a peer effect channel?  $z_i \rightarrow Share_{day}^{-i} \rightarrow y_i$

|                             | Personal Resilience | Social Resilience | Self-esteem        |
|-----------------------------|---------------------|-------------------|--------------------|
| Probability of being shared | 0.944*<br>(0.492)   | 0.789*<br>(0.472) | 1.244**<br>(0.544) |
| Observations                | 2,725               | 2,725             | 2,725              |

- Sharing bedtime stories is one channel for peer spillover.

# Mediation Analysis: Role of *Sharing with Me* Channel

We estimate the indirect effect of the treatment through the mediator: *proportion of boarders who shared their story with me*, using 500 bootstrap replications.

| Outcome      | Indirect Effect | Std. Err. | <i>z</i> | <i>p</i> -value | 95% CI           |
|--------------|-----------------|-----------|----------|-----------------|------------------|
| Resilience 1 | 0.0370***       | 0.0058    | 6.34     | 0.000           | [0.0256, 0.0485] |
| Resilience 2 | 0.0349***       | 0.0060    | 5.86     | 0.000           | [0.0232, 0.0466] |
| Self-esteem  | 0.0337***       | 0.0062    | 5.48     | 0.000           | [0.0217, 0.0458] |

Note: All indirect effects are significant at the 1% level. Results based on 500 bootstrap replications.

# Treatment Effect and Boarding Ratio

## Specification:

$$Y = \beta_0 + \beta_1 B + \beta_2 B^2 + \beta_3 B^3 \\ + \gamma_0 T_i + \gamma_1 T_i \cdot B + \gamma_2 T_i \cdot B^2 + \gamma_3 T_i \cdot B^3 + \text{Controls}$$

## Key Coefficient Estimates:

| Variable                  | Coef.  | p-value |
|---------------------------|--------|---------|
| Story (Treatment dummy)   | -0.27  | 0.175   |
| Boarding Ratio ( $B$ )    | -8.43  | 0.005   |
| $B^2$                     | +10.75 | 0.003   |
| $B^3$                     | -4.10  | 0.004   |
| $B \times \text{Story}$   | +1.61  | 0.022   |
| $B^2 \times \text{Story}$ | -1.93  | 0.192   |
| $B^3 \times \text{Story}$ | +0.55  | 0.621   |

- Only the linear interaction term is statistically significant.  
Higher-order effects are imprecise, but suggest non-linear moderation by treatment size. (use the coefficients to calculate optimal treatment size is 54.33%)

# Conclusion

- There is a positive spillover effect on personal resilience and self-esteem from treated students to untreated peers within the treatment group.
- The friendship network is the key channel: students with more treated friends or larger networks benefit more from the intervention.
- Peer effects are mainly driven by outcomes of strong ties (close friends); class-average peer outcomes become insignificant when close friends are controlled for.
- Sharing behaviour is an additional channel: students with more friends are more likely to share or be shared with, boosting self-esteem.

# Thank you!

# Overview

- 5 National-level poverty-stricken counties (out of 832 in total)
- The average education level is between primary and junior high school.
- Our sample: 46% left-behind, 70% never heard a bedtime story from parents

|  | All    | Sichuan Province | Hebei Province | Cangxi County | Wangcang County | Zhuolu County | Guyuan County | Yu County |
|--|--------|------------------|----------------|---------------|-----------------|---------------|---------------|-----------|
| 2015   |        |                  |                |               |                 |               |               |           |
| GDP per capita (Yuan)                                  | 49,922 | 37,150           | 35,994         | 18,738        | 21,897          | 27,408        | 25,546        | 17,481    |
| 2020   |        |                  |                |               |                 |               |               |           |
| GDP per capita (Yuan)                                  | 71,828 | 58,009           | 48,302         | 35,041        | 42,088          | 30,659        | 41,060        | 20,413    |
| Per capita disposable income of rural residents (Yuan) | 11,422 | 10,247           | 11,051         | 9,048         | 9,016           | 9,142         | 7,305         | 7,445     |
| Per capita disposable income of rural residents (Yuan) | 17,131 | 16,467           | 15,929         | 14,532        | 14,429          | 15,792        | 12,951        | 12,803    |
| Years of education                                     | 9.91   | 9.24             | 9.84           | 7.84          | 8.54            | 9.07          | 8.51          | 8.87      |

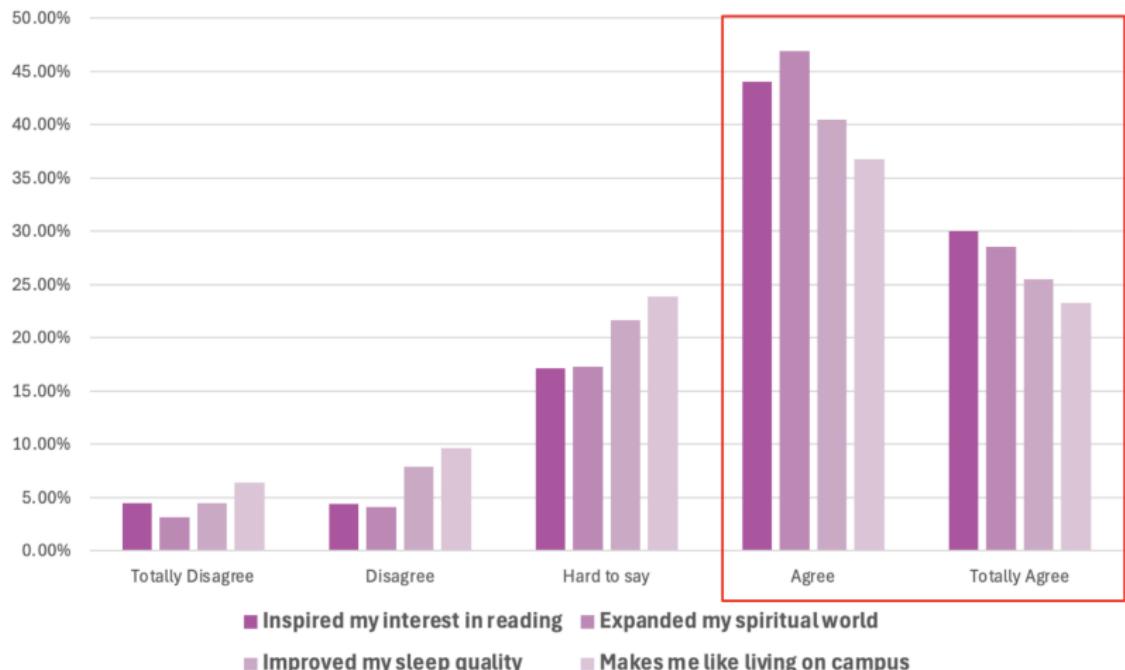
# Bedtime Story Example

The representative most frequently-played stories in 2023: [back](#)

- **That's Not a Hippo:** At the zoo, children and their teacher search for a lost hippo. Amidst the confusion, Liam persistently points out the real hippo, leading to a joyful find. [Animal, Nature]
- **The Wheelchair-bound Young Innovator:** Confined to a wheelchair by illness, teenager Chen Zipeng transcends his physical limits by clinching top innovation awards. His creations, a "smart mousetrap" and "smart stray pet feeder," earned him first prizes at national IT competitions and the World Internet of Things Expo. [Strength, Innovation]
- **Scarborough Fair:** weaves a poignant story of a soldier's love lost to war, his memory living on in a herb-filled village—a symbol of undying affection, a serene hymn to life's preciousness, and peace's gentle pursuit, radiating love's pure glow. [Love, Peace, Antiwar]

# How Did the Students Find the Stories?

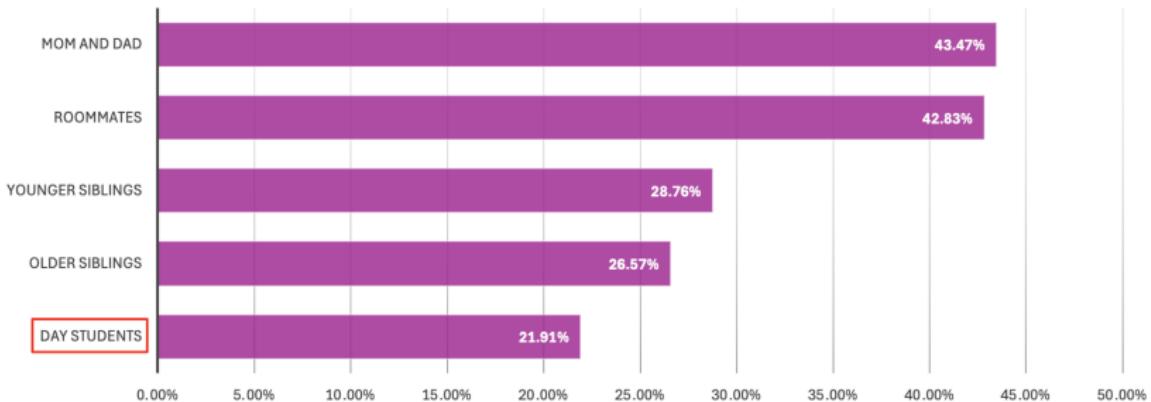
## HOW DID STUDENTS FIND THE STORIES



back

# Did the Students Share the Stories to Others?

## Who did you share the stories with?



back

# Randomization

|                | Schools | Observations |
|----------------|---------|--------------|
| Audio Story    | 30      | 3,911        |
| Book           | 30      | 3,673        |
| Audio and Book | 29      | 3,868        |
| Control group  | 33      | 4,325        |
| Control county | 15      | 2,021        |
| In total       | 137     | 17,798       |

data

# Balance Test

|                                  | Board Student      |                    |                        | Day Student        |                    |                        |
|----------------------------------|--------------------|--------------------|------------------------|--------------------|--------------------|------------------------|
|                                  | Control            | Treat              | P-value/<br>RW p-value | Control            | Treat              | P-value/<br>RW p-value |
| <b>Personal Characteristics:</b> |                    |                    |                        |                    |                    |                        |
| Age                              | 10.316<br>(0.828)  | 10.266<br>(0.866)  | 0.610<br>[0.979]       | 10.146<br>(0.798)  | 10.108<br>(0.792)  | 0.757<br>[0.985]       |
| Gender                           | 0.529<br>(0.499)   | 0.517<br>(0.500)   | 0.550<br>[0.997]       | 0.443<br>(0.497)   | 0.499<br>(0.500)   | 0.004<br>[0.719]       |
| Grade                            | 4.527<br>(0.499)   | 4.512<br>(0.500)   | 0.650<br>[0.996]       | 4.461<br>(0.499)   | 4.456<br>(0.498)   | 0.844<br>[1.000]       |
| Height                           | 138.912<br>(7.701) | 138.810<br>(7.885) | 0.912<br>[1.000]       | 139.078<br>(7.740) | 138.316<br>(7.606) | 0.387<br>[0.823]       |
| Weight                           | 33.367<br>(8.293)  | 32.844<br>(7.344)  | 0.528<br>[0.960]       | 33.555<br>(8.635)  | 32.911<br>(7.489)  | 0.521<br>[0.873]       |
| Left-behind                      | 0.430<br>(0.495)   | 0.456<br>(0.498)   | 0.627<br>[0.981]       | 0.408<br>(0.492)   | 0.423<br>(0.494)   | 0.788<br>[0.989]       |
| <b>Family Characteristics:</b>   |                    |                    |                        |                    |                    |                        |
| Mother's Education               | 8.137<br>(2.004)   | 8.111<br>(2.067)   | 0.837<br>[1.000]       | 8.587<br>(2.118)   | 8.794<br>(2.201)   | 0.213<br>[0.823]       |
| Father's Education               | 8.605<br>(2.013)   | 8.618<br>(2.027)   | 0.906<br>[1.000]       | 8.998<br>(2.192)   | 9.370<br>(2.187)   | 0.026<br>[0.565]       |
| Parents' Marriage                | 0.134<br>(0.341)   | 0.130<br>(0.337)   | 0.087<br>[1.000]       | 0.098<br>(0.281)   | 0.440<br>(0.297)   | 0.465<br>[0.989]       |
| <b>Outcome Variables:</b>        |                    |                    |                        |                    |                    |                        |
| Resilience                       | -0.015<br>(0.996)  | 0.002<br>(0.956)   | 0.780<br>[1.000]       | 0.046<br>(1.003)   | 0.046<br>(0.971)   | 0.999<br>[1.000]       |
| Self-esteem                      | -0.374<br>(0.909)  | -0.339<br>(0.865)  | 0.427<br>[0.996]       | -0.382<br>(0.866)  | -0.376<br>(0.897)  | 0.883<br>[1.000]       |
| Sleeping quality                 | 35.859<br>(5.120)  | 35.785<br>(4.929)  | 0.746<br>[1.000]       | 34.871<br>(5.302)  | 34.782<br>(5.137)  | 0.792<br>[1.000]       |
| Depression                       | 0.024<br>(1.000)   | 0.074<br>(0.983)   | 0.417<br>[0.981]       | -0.114<br>(0.978)  | -0.127<br>(0.958)  | 0.858<br>[1.000]       |
| Math                             | 0.185<br>(0.827)   | 0.125<br>(0.804)   | 0.100<br>[0.960]       | 0.154<br>(0.815)   | 0.376<br>(0.709)   | 0.025<br>[0.193]       |
| Reading                          | -0.402<br>(0.816)  | -0.428<br>(0.779)  | 0.750<br>[0.996]       | -0.435<br>(0.807)  | 0.022<br>(0.757)   | 0.383<br>[0.849]       |
| # friends                        | 4.030<br>(1.362)   | 3.795<br>(1.695)   | 0.482<br>[0.689]       | 4.115<br>(1.256)   | 3.914<br>(1.573)   | 0.398<br>[0.713]       |

data

# Attrition

- Attrition is not related to treatment status

|         | Board Student    | Day Student      | Board Student    | Day Student      |
|---------|------------------|------------------|------------------|------------------|
| 2016    | 0.244<br>[0.284] | 0.758<br>[0.787] | 0.154<br>[0.295] | 0.569<br>[0.823] |
| 2017    | 0.000<br>[0.001] | 0.138<br>[0.333] | 0.000<br>[0.001] | 0.054<br>[0.184] |
| 2020    | 0.151<br>[0.284] | 0.368<br>[0.625] | 0.531<br>[0.504] | 0.713<br>[0.823] |
| Control | No               | No               | Yes              | Yes              |

- Attrition is not related to baseline outcomes

|                              | Attrition (Day students)<br>(2) | Attrition (Board students)<br>(3) |
|------------------------------|---------------------------------|-----------------------------------|
| Cohort's Personal Resilience | -0.017<br>(0.031)               | 0.005<br>(0.024)                  |
| Cohort's Social Resilience   | 0.016<br>(0.022)                | 0.006<br>(0.018)                  |
| Cohort's Internalization     | -0.010<br>(0.007)               | 0.003<br>(0.008)                  |
| Cohort's Externalization     | 0.007<br>(0.008)                | 0.002<br>(0.008)                  |
| Cohort's Self-esteem         | 0.011<br>(0.013)                | -0.001<br>(0.011)                 |
| Cohort's Depression          | 0.007<br>(0.005)                | 0.008<br>(0.006)                  |
| Observations                 | 2,374                           | 3,342                             |
| County FE                    | Yes                             | Yes                               |
| Other controls               | Yes                             | Yes                               |

# Measurement

$$Z_{ij}^* = v_j + \lambda_j^\top Y_i + u_{ij}.$$

$$Z_{ij} = s \quad \text{if} \quad \tau_{s,j} \geq Z_{ij}^* \geq \tau_{s+1,j} \quad \text{for} \quad s = 1, 2, 3, 4$$

with  $\tau_{1,j} = -\infty$  and  $\tau_{4,j} = \infty$

- $Y_i$ : latent factors
- $Z_{ij}$ : available measures (1=strongly disagree, 2=disagree, 3=agree, and 4=strongly agree, ordered in the same direction)
- $v_j$ : item-specific intercepts
- $\lambda_j$ : loadings
- $u_{ij}$ : independent measurement error term
- $\tau_j$ : item- and group-specific threshold parameters

$$Y_i \sim \mathcal{N}(\kappa, \sigma_Y^2) \quad \text{and} \quad u_{ij} \sim \mathcal{N}(0, \sigma^2).$$

- normalization:  $k = 0, \sigma_Y^2 = 1, v_j = 0, \sigma^2 = 1$
- Factor scores not orthogonal: a dedicated factor structure (from EFA) based on the oblique factor rotation matrix (oblimin)

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